TECHNOLOGY TRANSFER

Information

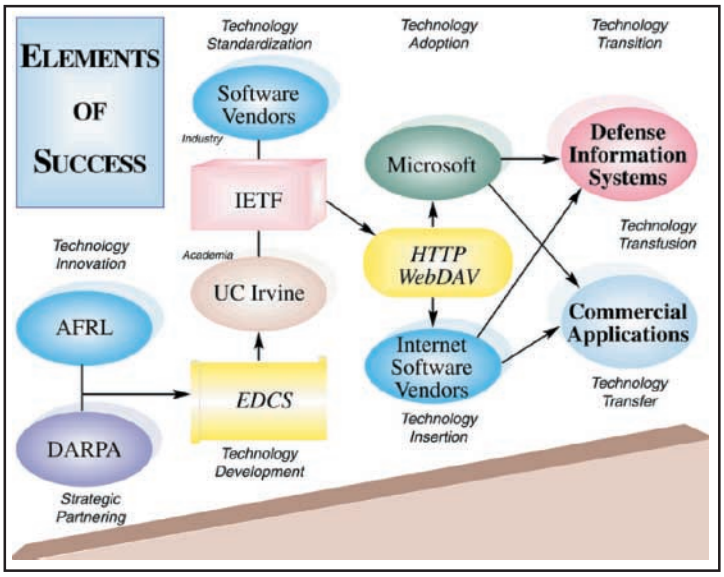
Materials and Manufacturing

Propulsion

Air Vehicles

MICROSOFT® CORPORATION ADOPTS AFRL-SPONSORED TECHNOLOGY

I



PAYOFF

Microsoft® Corporation, the worldwide leading provider of software for personal computers, adopted an Information Directorate-developed technology called Web Distributed Authoring and Versioning (WebDAV). This new technology allows users to share and work with server-based documents regardless of their authoring tools, platforms, or the types of web servers on which they are stored. The WebDAV set of extensions to the HyperText transfer protocol permits users of these systems to read and write documents over the Internet.

ACCOMPLISHMENT

The Evolutionary Design of Complex Software (EDCS) program, funded by the directorate and the Defense Advanced Research Projects Agency, contracted with the software research group at University of California (UC), Irvine, to lead the WebDAV working group of the Internet Engineering Task Force (IETF) from its inception. Microsoft®, in conjunction with other vendors such as Netscape® Communications, Novell®, and Xerox®, worked with UC, Irvine, and the IETF to help define this new specification. Microsoft® announced its plans to use WebDAV in a variety of its future products. Incorporating this technology into Microsoft® Windows and Windows NT operating systems; Microsoft Office™ tool suite; and other Microsoft® products, such as FrontPage™ and BackOffice,™ increases its benefit to an enormous consumer base.

BACKGROUND

Since the inception of the EDCS program in 1996, the UC, Irvine, technology project (one of over forty EDCS technology projects) has taken leadership in World Wide Web (WWW) standardization efforts of the IETF. The EDCS program is positioned with the unique ability to transition research and development efforts to the next generation of WWW technology.

Collaborative Environment Provides Distributed Knowledge Sharing

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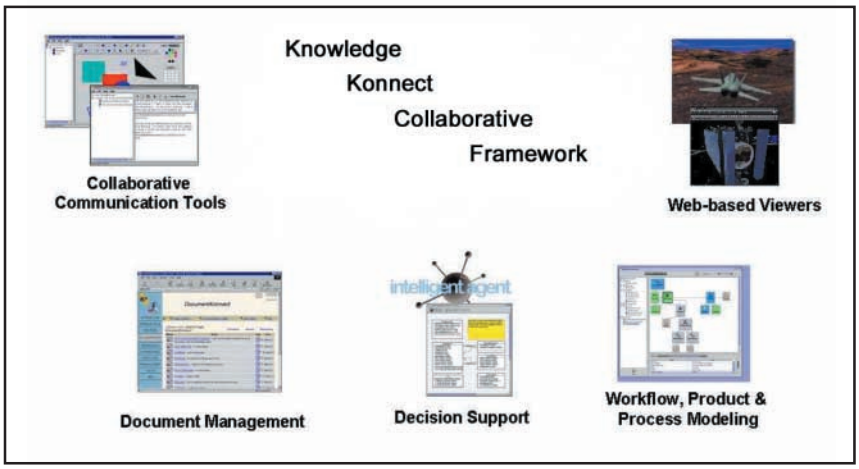


Payoff

In the 21st century information-centric enterprises, geographically separated teams of engineers, scientists, managers, and other specialists will jointly develop new products. These teams will access computer-based engineering tools, models and simulations, knowledge bases, and dispersed special facilities. The defense and commercial sectors are moving toward virtual and collaborative solutions to bring the right systems to market at the right time and at the right price. The Information Directorate's Information Systems Division is developing a Collaborative Enterprise Environment to improve quality, reduce cost of development, and reduce the time to manufacture a product.

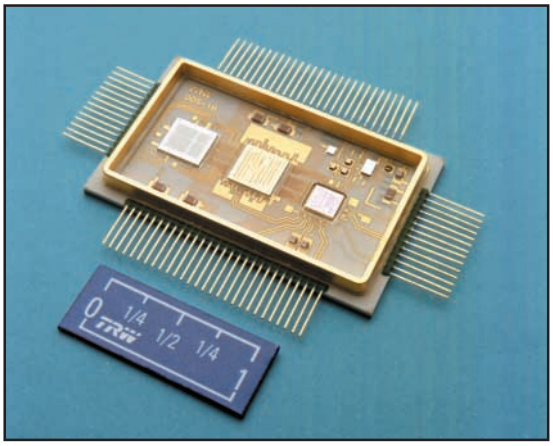
Accomplishment

The Air Force Dual Use Science & Technology Collaborative Enterprise Environment program transferred leading-edge information technology to the commercial sector that resulted in a new commercial product. Ball Aerospace & Technologies Corporation announced release of the first version of their K² ™ standards-based collaborative framework. K² ™ leverages information and simulation technology to enhance decision support by linking information and tools to get critical information to decision-makers when and where they need it.

Background

Collaborative engineering and virtual prototyping technology addresses the technical and system architecture needed for the Department of Defense (DoD) initiative on simulation based acquisition - part of defense acquisition reform. This effort is leveraging lessons learned from commercial sector reorganization and restructuring and applying them to DoD in order for the armed forces to maintain their competitive military edge in the rapidly changing global arena. Two previous live experiments demonstrated the capability to enable collaboration across technology domains (requirements definition, satellite sensor design, hyperspectral data processing, human effectiveness, command and control, intelligence, manufacturability, and affordability) located in four dispersed geographical areas.

Multi-Layer Ceramic Substrate Lowers Electronics Packaging Costs



Payoff

Low-temperature-cofired-ceramic-on-metal (LTCC-M) technology permits integration of resistors, capacitors, inductors, and microwave transmission lines into multi-chip substrates. Successful transfer of LTCC-M technology lowers packaging cost in advanced communication, mobile computing, electronic warfare, radar, and other systems vital to national defense, while advancing technology that could boost production quality in the private sector.

Accomplishment

A research effort supported by the Materials and Manufacturing Directorate, the Defense Advanced Research Projects Agency, and private industry led to the development of a multi-layer ceramic substrate that reduces the electronics packaging costs for defense systems. The LTCC-M technology uses embedded passive components that facilitate the integration of resistors, capacitors, inductors, and microwave transmission lines into multi-chip substrates.

Background

Integrating passive components into substrates reduces overall assembly costs by eliminating inventory expense, component attachment and wire bonding operations, and also leads to increased product reliability. Examples of integrated passive components are filters, voltage dividers, and impedance matching networks. The first successful example of an LTCC-M substrate with integrated passive components was a wideband 2 to 18 GHz amplifier, designed by Northrop Grumman, which demonstrated the integration of eight capacitors and two resistors. This was followed by the design and fabrication of TRW's direct digital synthesizer. The program was performed by the Technology Alliance for Mixed Signal, a consortium comprised of researchers from Sarnoff Corporation of Princeton, New Jersey and Dielectric Laboratories, Inc. (DLI) of Cazenovia, New York, under a cooperative agreement with the directorate. Sarnoff developed a versatile LTCC-M technology with integrated passive components and transferred this technology to DLI, a merchant supplier, who established a manufacturing facility and then entered the LTCC-M ceramic package and substrate market with its DiPak™ product line. DLI is currently offering DiPak™ packages and substrates to frequencies as high as 40 GHz. This effort demonstrated that the combination of low-loss ceramic, low-loss microwave frequency transmission lines, and a high-thermal-conductivity metal core makes LTCC-M suitable for substrates and packages in systems involving communication, mobile computing, electronic warfare, and radar. Researchers also demonstrated that the integration of passive components into mixed-signal substrates can greatly reduce module size, enabling more compact product designs with more features than current packaging and interconnect technology. As a result of this program, LTCC-M successfully demonstrated the integration of digital and microwave circuits on a single substrate. The program also developed a comprehensive design kit for the simulation and layout of multi-layer LTCC-M substrates containing embedded lumped passive components, surface transmission lines, and embedded transmission lines. The user-friendly design kit works with the industry standard Hewlett-Packard Communications Design Suite Series IV.

PAP-E Program Saves Time and Money in Electronic Test Equipment

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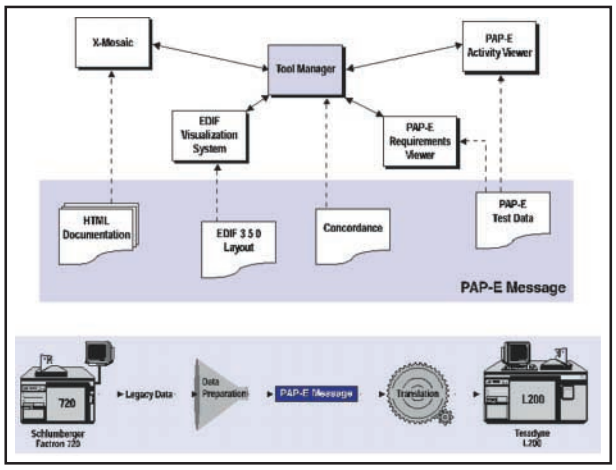


Payoff

The technology developed through the Product Data Exchange using STEP (Standard for the Exchange of Product Data Model) or PDES Application Protocol for Electronics (PAP-E) program will help the Air Logistics Center (ALC) and contractor communities handle anticipated electronic repair taskings, reduce the cost to rehost test program sets (TPSs), and save millions of dollars. This information modeling technology is being transferred to several commercial and government standard efforts.

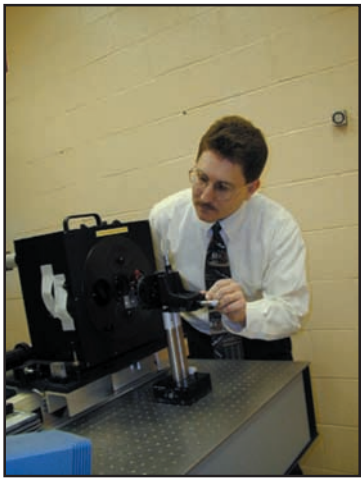
Accomplishment

Under a contract with the Materials and Manufacturing Directorate, Averstar Inc. developed technology to dramatically reduce the cost and time required to support maintenance test equipment for weapon systems' electronics. The PAP-E program reduces the cost to rehost a TPS for an electronic assembly from $150,000 to $80,000 and reduces the time needed to complete rehosting from three months to one month.

Background

The PAP-E program evolved out of a Department of Defense (DoD) study which assessed the problems associated with using electrical and electronic product data exchange standards. Printed circuit boards and shop replaceable units represent a significant workload within the ALC and defense system contractor environments with increased repair activities forecasted for these components. The study concluded that product data for modular avionics would increase, and current support capabilities could not handle the repair, test, and support requirements levied on the ALCs without standard product data and automation technology. The PAP-E program will support advancements in the state-of-the-art technology without losing sight of harmonization needs for the current array of diverse data exchange standards and data standards organizations. Prior to the development of PAP-E technology, rehosting a TPS (moving the TPS software from one tester to another) was not always economically feasible. The development of peculiar automatic test equipment (ATE) supporting individual weapon systems was prevalent in the DoD until the late 1980s. High life-cycle support costs with a low frequency of utility, and the use of proprietary data formats with the concurrent risk of future insupportability, are major problems with peculiar ATEs developed for legacy weapon systems. PAP-E technology provides an economical solution by reducing the cost to rehost test program sets from both supportable and unsupportable peculiar ATE, to a family ATE based on industry standard formats that are adaptable to future rehosts. The PAP-E demonstrated that using an information model-based solution to rehost a TPS from one ATE platform to another can yield significant savings. The final demonstration yielded a 15-to-1 improvement in first pass article testing and a 6-to-1 improvement in overall TPS rehost capability. The use of the concordance technology allows the support of existing standards and formats, while formally binding the core test model to actual data. A fully automated PAP-E toolset would allow the Navy to save over $667 million to rehost software from six aviation testers to their new family of ATE.

Photomechanics Laboratory Helps Evaluate Aerospace Composite Materials



Payoff

The Photomechanics Laboratory provides a cost-effective means for evaluating the micromechanical and global behavior of composite materials. The test methodologies employed at the facility provide a highly accurate capability for assessing the strength characteristics of composite materials that could prove important to future aerospace systems, and will lead to a better understanding of the nature of composite materials. The availability of the laboratory to the Department of Defense (DoD), academia, and industry optimizes its utility in expanding the role of composite materials through the entire applications spectrum.

Accomplishment

Researchers at the Materials and Manufacturing Directorate developed a dynamic in-house laboratory to evaluate materials that may help strengthen composites used to build aircraft and space vehicles for the Air Force and DoD. The facility, recently expanded and managed by scientists in the directorate's Structural Materials Branch, is currently in its second year of operation. The laboratory is also available to assist other military services, academia, and private industry, which benefits the national defense-at-large and could lead to innovative commercial applications.

Background

The Photomechanics Laboratory uses three widely-accepted test methods to evaluate the micromechanical and global behavior of composite materials: moiré interferometry, photoelasticity, and microscopic observation. Moiré interferometry is a well-established technique used for full-field, in-plane displacement measurements, which can be applied to a broad range of engineering complexities. Primary application areas for moiré interferometry include structural assessments, material processing studies, prototype modeling, high temperature studies, and material studies on metals, plastics, and composites. The moiré technique works by exposing a diffraction grating attached to the laboratory sample to two beams of collimated laser light. The Photomechanics Laboratory also uses photoelasticity, an experimental method for measuring stress fields and inferring strain fields in transparent solids. The presence of stresses in certain transparent materials alters the material's refractive index. The third test method employed at the laboratory involves researchers studying failure mechanisms via real-time microscopic observation of photoelastic fringes at the crack tip of fiber-matrix interface debonds, as well as observations of differences in the intensity of light reflected from a debonded interface. The extent and profile of interface damage was measured under both shear and tensile loading of the interface to simulate various macroscopic loadings of a composite. Further development of this procedure, known as the "cruciform test," will help materials researchers evaluate graphite fiber surface treatments and coating modifications more accurately.

Integrated Modeling and Simulation Tools Save Money

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Payoff

Successful implementation of the Simulation Assessment Validation Environments (SAVE) program technology in the manufacture of new weapon systems will result in better quality and reliability, improved flexibility in product changeovers, shorter cycle times, increased effectiveness, and lower cost. As a result of the SAVE program's enhanced virtual design and manufacturing environment and tools, the program's benefits forecast a potential savings of 1% to the F-22 current air vehicle average unit cost, or approximately $716K/aircraft. For a new acquisition system like the Joint Strike Fighter (JSF), the potential benefits are projected between 2-3% of the total life cycle cost, or a potential total cost avoidance of over $1 billion.

Accomplishment

Under a contract with the Materials and Manufacturing Directorate, Lockheed Martin Corporation successfully demonstrated virtual manufacturing (VM), integrating modeling and simulation tools to assess the impacts of product and process decisions on the affordability of advanced strike warfare technology. These simulation tools will allow optimal decisions in the design and manufacture of new aircraft. The SAVE program is a new approach to separating low cost from high volume in military aircraft manufacturing.

Background

Military aircraft manufacturing does not enjoy the traditional cost benefits of mass production because mass quantities are not usually required. VM supports the concept of separating low cost from high volume by applying modeling and simulation technology to prove out and select optimal new concepts. The SAVE program is a first step in realizing the near-term objectives common to VM and the JSF program. This effort focused on initial implementation of VM strategically applied to specific real fighter or attack aircraft design and production affordability problems. The initial phase of the program established a core tool suite integrated via the Defense Advanced Research Projects Agency-developed rapid prototyping of application specific signal processors architecture. The core tool suite incorporates commercial computer-assisted design, factory simulation, assembly simulation, schedule simulation, and cost and risk modeling capabilities. In Phase I of SAVE, the core VM capabilities were validated, performance and business metrics were identified against real production problems, and areas for continued refinement and enhancement were identified. Under Phase II, the SAVE team developed a common object request broker (CORBA)-based approach to tool integration, which provides a solid foundation for ultimate production use and commercialization of SAVE. The CORBA-based infrastructure now includes the SAVE common data model, a work flow manager, and a query system for interactive access to the data model. In addition, commercially-available dimension and tolerance simulation capabilities were added to the VM environment. The SAVE infrastructure was twice demonstrated during re-design activities for the F-22, first for the F-22 gun port, and again for the F-22 weapons bay door assembly and its installation onto the aircraft. The modeling and simulation standards community are transitioning the SAVE program software and development specifications to industry. Additionally, the first commercial software product based on SAVE, Cognition's Knowledge Center, was recently released.

Joint Air Force and Central State University Project Improves Manufacturing Technology Workforce

Payoff

The Cell for Integrated Manufacturing, Protocols, Architectures and Logistics (CIMPAL) project contributed greatly to the physical resources and expertise available at Central State University (CSU) to deliver manufacturing engineering technology education to academia and industry. The program enhanced regular classroom and laboratory instruction, as well as support for student research projects, and the university's ability to conduct research relative to modern manufacturing technology. This program will result in a future workforce better prepared to meet defense manufacturing needs.

Accomplishment

Under a contract with the Materials and Manufacturing Directorate, CSU developed a computer integrated manufacturing laboratory to better prepare the workforce contributing to the nation's sophisticated technological defense requirements. The CIMPAL project played a major role in CSU achieving accreditation from the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology – this was one of the nation's first of such programs to be so recognized.

Background

Small manufacturers face difficulties finding skilled workers and engineers. To maintain and increase global competitiveness of US manufacturing, industry must address the education of its current and future workforce. Companies must upgrade and improve the skills of current manufacturing employees, attract the brightest and best to the manufacturing field, and ensure the educational system develops appropriate curriculums. This Air Force Manufacturing Technology project was a response to an announcement soliciting proposals from historically black colleges and universities (HBCU's) and minority institutions for activities that would enhance their ability to address Air Force research and development needs. CSU is Ohio's only predominantly African-American, state-assisted institution of higher education and the nation's only HBCU with a self-contained bachelor of science degree program in manufacturing engineering. Moreover, CSU's existing Manufacturing Engineering Department possessed considerable technical expertise and physical resources to support manufacturing research. For this project, CSU supplemented its team of faculty members and student research assistants with consultants from Cincinnati Milacron of Cincinnati, Ohio, and Automation Research Systems Ltd. of Alexandria, Virginia.

Revolutionary Composite Crutch Could Reach Worldwide Market

8

Payoff

Developed under a Cooperative Research and Development Agreement (CRADA), Ergonomics, Inc., based in Dayton, Ohio, will manufacture a new composite crutch and market it through the Internet. Under the agreement, the directorate will receive a percentage of gross annual sales.

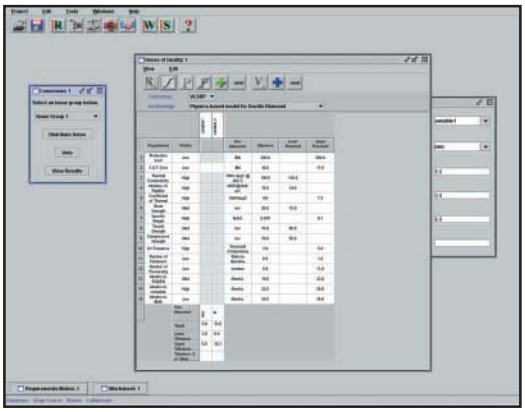
Accomplishment

Researchers at the Materials and Manufacturing Directorate designed and developed the world's first carbon-fiber composite, forearm crutch. The new crutch is lighter, stronger, and quieter than the former aluminum design.

Background

During the past several years, Ergonomics, Inc., a retail seller of ambulatory crutches, canes, and walkers, received numerous complaints from long-term users regarding the heavy weight of aluminum forearm crutches. These complaints led Ergonomics to search for an alternative forearm crutch made from lightweight composite materials. Upon learning of the directorate's composite capabilities, Ergonomics contacted them for assistance, which eventually led to a CRADA administered through the Wright Technology Network. Initially, the directorate's engineers consulted with long-term crutch users to determine user needs. Crutch weight was the primary concern for users, who preferred crutches weighing at least half that of aluminum models. They also wanted a more durable crutch that would neither crack nor cause tendon or arthritic problems, as well as a more attractive looking device. A traditional design that encompassed the benefits of composites and alleviated some of the metallic crutches' inherent problems (e.g., mushrooming, cracking, wear) interested Ergonomics. Relatively heavy aluminum crutches, weighing about 5 lbs per pair, in time become noisy when the height adjustment pin holes become elongated due to wear. Since a vast majority of those surveyed are lifetime users, the feature to readjust the height of the crutch was eliminated with most of the noise problem and a further reduction in weight. The composite crutches will be custom-made—customers specify part sizes and select from a wide stock of varying lengths, handle sizes, and top tube or cut-to-order sizes. The composition of the crutch consists of relatively inexpensive material - graphite fiber and epoxy. The initial cost of the device exceeds conventional aluminum models, but is offset by a 60% weight reduction, 20% increase in strength, quieter design, and a considerably longer life span.

Process Analysis Toolkit for Affordability Saves Time and Money



Payoff

The process analysis toolkit for affordability (PATA) helps users define, quantify, and attack risk drivers; defend key decisions and program budgets; manage changes and assess program impact; and improve team-based planning. More than 20 Air Force, Army, and Navy programs use PATA tools. In one joint program, a reduction from three months to two weeks in design cycle time for advanced engine turbine blades occurred. A reduction in downstream deployment costs for defensive countermeasure systems by more than 50% took place, saving several hundred million dollars. An Army project used these tools to arrive at 25% under budget and 20% ahead of schedule, while achieving better than expected performance.

Accomplishment

Under a contract with the Materials and Manufacturing Directorate, James Gregory Associates, Inc. developed decision analysis software to predict the level of success of a projected organizational program, minimize costs, and identify technologies that represent the best value to the customer. PATA provides new capabilities for performing integrated product and process development (IPPD) and saved thousands of dollars pursuing less effective technologies.

Background

IPPD is a measurement-based management strategy involving cross-functional teams for determining the best value in selecting new technologies to develop. A commercialized, high-quality PATA enables life-cycle performance costs and schedule affordability analyses during the research and development phase of technology development and transition to acquisition. PATA is inexpensive to apply because it takes advantage of the rapidly growing Internet infrastructure, while its unique browser technology and related standards provide convenience and ease of use. The browser supports a wide variety of activities, from on-line shopping (transaction management) to information retrieval, application sharing, and collaborative design. PATA assists users through a series of tools and worksheets, automating the IPPD process by connecting the information in one tool to relevant requests in another tool. The Excel-based PATA currently includes a requirements matrix, desirability curve tool, weighting requirements, a technology alternatives tool, IPPD worksheets, point estimation and curve estimation technique tools, a zeta calculator, a tool for establishing design variables, a tool for exploring the design space, a house of quality, and a value scorecard. The requirements matrix collects the data to determine and describe customer requirements through a set of quantifiable measures for each requirement. The PATA tool prompts the user to establish customer name, requirement, priority, how measured, objectives and thresholds, and type of requirement. The desirability tool uses that information to establish a desirability curve and permits the user to adjust it to indicate the extent to which a customer will become satisfied or dissatisfied with requirements that are partially met. Using the desirability tool, users can see the graphic function that illustrates that satisfaction. Another tool can record technology alternatives to be evaluated against requirements. Worksheets can to record and calculate the metrics of the technology alternative against customer requirements. Other tools assist in performing analyses of the requirements and technologies, exploring the design space, building quality, and constructing requirements and technology alternatives into an overall value scorecard.

Advancements In Optical Absorption Monitoring

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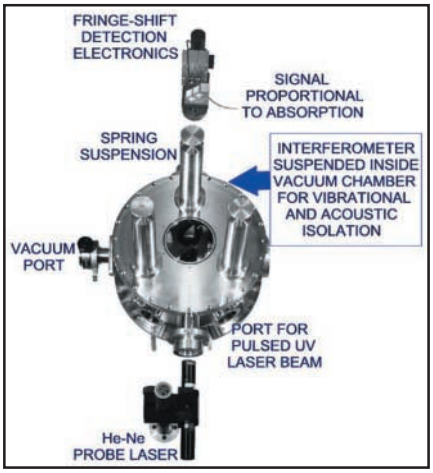

Payoff

Developed under the Small Business Innovation Research (SBIR) program, the new optical measuring instrument is more precise than any technology currently available to the Air Force. Successful transfer of the technology to commercial industry enhances product research and development, and could lead to applications of lithographic technologies benefiting science, medicine, communications, aerospace, and other critical fields.

Accomplishment

Academia and industry counterparts used an innovative technology developed for the Air Force to detect and measure rocket fuel emissions and improve microscopic electronic circuit boards and miniature transistors. Developed by Science Research Laboratory (SRL), Inc., with the support of the Materials and Manufacturing Directorate, the monitor measures absorbed ultraviolet light with 10 times more accuracy than current technologies.

Background

The use of toxic and potentially harmful hydrazines in some rocket fuels concern the military space community. To ensure public safety, the Air Force Space Command needed an instrument to measure airborne hydrazines down to parts-per-billion in real time. Under a SBIR Phase II effort, SRL, Inc. developed a portable, ultra-sensitive, interferometric monitor that measures changes in the optical path of a pulsed excitation laser beam, after pollutants absorb the beam, to detect hydrazines and other pollutants. When a gas absorbs light from a beam, its temperature rises, causing it to expand and become less dense in the laser-irradiated region. When this irradiated region is in one arm of an optical interferometer, the unit uses a continuous-wave probe laser beam with great sensitivity to detect the change in the optical path length (correlating to gas concentration). The instrument met the project's measurement objectives but was unable to achieve the necessary sensitivity in the uncontrolled open atmosphere due to interfering chemical species (primarily carbon dioxide). In the process of improving the instrument's sensitivity, engineers discovered the instrument was exceptionally good at ultra-sensitive measurement of coating absorption, particularly in the ultraviolet (UV) portion of the spectrum. Coating manufacturers expressed an interest in this new technology, citing the sensitivity is at least 10 times greater than existing monitoring devices. An industrial consortium representing the lithography industry purchased one of the monitors for use at the MIT Lincoln Laboratory to evaluate the absorption of various optical materials used to transmit UV laser beams that write microscopic patterns on lithographic wafers—the type used to manufacture microscopic electronic circuit boards, miniature transistors, and other vital technologies. In addition, SRL developed and commercialized a two-color interferometer, called an "interferometric calorimeter," that enables next-generation lithography to achieve critical dimensions of 0.1 micron and below. This advanced monitoring device corrects for refractive-index variations, thereby improving the accuracy and viability of the smallest lithographic feature size.

Royal Danish Air Force Adopts JP-8+100 as Standard Fuel

Payoff

The Royal Danish Air Force (RDAF) has adopted the AFRL-developed +100 thermal stability fuel additive for use in the majority of their aircraft. This move ensures North Atlantic Treaty Organization (NATO) aircraft refueling in Denmark will receive the best available fuel, whether JP-8 or JP-8+100. This is a significant move towards ensuring the interoperability of NATO forces and reducing engine maintenance costs for participating aircraft utilizing +100.

Accomplishment

The RDAF converted to JP-8+100 primarily to alleviate concerns about coking in aircraft engines and fuel systems. To insure interoperability with other nations, many of which have yet to adopt the +100 additive, the RDAF chose to inject the additive into fuel when pumped from the fuel truck to the aircraft. This differs from the US procedure of adding the +100 additive to the fuel as it is loaded from storage tanks onto the fuel truck. The RDAF purchased Hammonds Technical Services, Inc. fuel additive injection systems, modified their refueling trucks, and began operating their aircraft on JP-8+100 in November 1999 at Skrydstrup Airbase. Danish aircraft operating on JP-8+100 include the F-16 Fighting Falcon, the C-130 Hercules, the Gulfstream G-III, and the Canadair CL-604 Challenger. After only two months of using the additive, the Danes, through visual inspection, saw cleaner engines.

Background

The Propulsion Directorate's Fuels Branch developed the +100 fuel additive for use in JP-8, the Air Force's primary aviation fuel, in response to increasing thermal demands on the fuel. As engine technology advances, the fuel increasingly serves a dual function. The fuel's primary purpose is to provide propulsive energy, but additionally, the fuel is used as a coolant to extract heat from aircraft airframe and engine systems. Because of this role as a coolant, fuel temperatures rise along with a tendency for the fuel to form deposits (called coke) that accumulate on engine components. These deposits degrade the performance of components, increase maintenance costs, and in extreme cases, pose a safety hazard. The +100 fuel additive effectively reduces the tendency to form harmful deposits. The technology was transitioned to the San Antonio Air Logistics Center Special Fuels Branch who leads the Air Force implementation of JP-8+100. The additive, now used at 59 locations worldwide, is gaining wide acceptance, having flown approximately one million flight hours in more than 2,000 USAF aircraft. The additive is also used commercially in police helicopters.

AFRL Drives Transfer of Advanced Material for High-Performance Electronic Components

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Payoff

Current, commercial, state-of-the-art (SOTA) power capacitors are becoming unreliable in military systems due to the high temperatures produced in modern weapon systems. A program led by the Propulsion Directorate developed a fluorene polyester capacitor film, which has twice the operating temperature capability of SOTA capacitors. This film also enables power capacitors with a 40% decrease in weight and 30% increase in reliability.

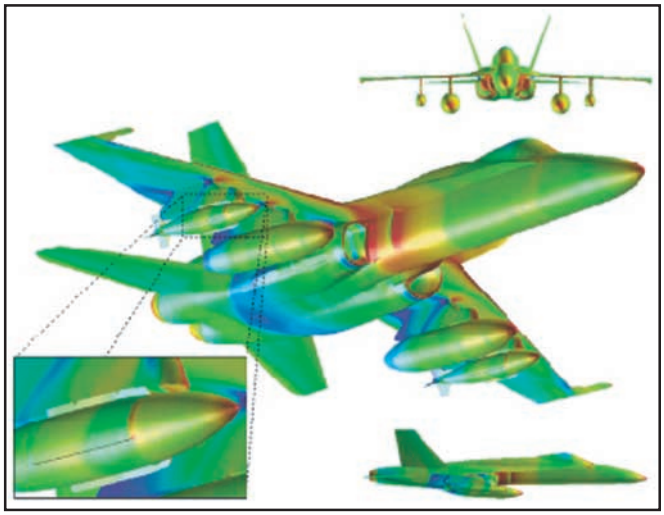
Accomplishment

Under the high temperature dielectric program, the directorate's Electrical Branch, developed a flourene polyester (9,9-bis- [4-hydroxphenyl]-flourene iso/terepthlate) dielectric film with properties beyond SOTA polycarbonate and polypropylene films. Current capacitors have a high-temperature capability of 125°C. This film has a high-temperature capability of 250°C and also two times the voltage breakdown strength of polycarbonate films. These characteristics enable capacitors with the capability of handling the temperatures seen in current weapons systems that are beginning to exceed SOTA capacitor capability in some instances. The film also has applications in severe-environment commercial applications, such as "in hole" oil well applications, aircraft engine ignition systems, and medical defibrillators.

Background

While the military requires high performance capacitors to satisfy mission requirements, the military is a low volume user compared to commercial applications. Both capacitor and capacitor film manufacturers are reluctant to develop capacitors or film to meet these requirements as long as their current capacitors satisfy high volume commercial customer applications. As a result, a program was initiated with industry to develop and produce a capacitor film to meet high-performance military requirements. This effort involved over 17 organizations – two government and 15 commercial enterprises. The directorate worked with the film producers as well as capacitor manufacturers and, after several years, by October 1999, a capacitor grade 12-micron film was available to capacitor manufacturers. There is also a need for thinner films in the 2- to 6-micron range for certain applications. The directorate's efforts resulted in one firm working to produce the casting process for these thinner films and two other firms using the casting process in a production mode.

High-Performance Computing of Fluid Dynamics



Payoff

The *Cobalt*$_{60}$ software package, developed by the Air Vehicles Directorate under the auspices of the Department of Defense (DoD) common high-performance-computing software support initiative, provides a robust, accurate, and affordable computational-based capability to support aerospace research and development throughout all DoD organizations, as well as other customers in industry and academia. Specific support to warfighters and field units is now realized in a matter of days or weeks, whereas only a few years ago, unsteady turbulent simulations required months or more of turnaround time. Increased emphasis on modeling, simulation, and computer-generated data is expected to result in major cost savings compared to traditional aerodynamic data-generating techniques such as ground and flight tests.

Accomplishment

Cobalt$_{60}$, based on conventional numerical simulation techniques to solve the Euler and Navier-Stokes equations of fluid motion, includes innovative procedures that address effective parallel processing for unstructured data domains of arbitrary complexity. Over the past two to three years, *Cobalt*$_{60}$ was used for a variety of vehicle aerodynamic designs and analyses in nearly all flight regimes, from near-incompressible flow to very high Mach number flow.

Background

The fundamental algorithm used in *Cobalt*$_{60}$ is Godunov's first-order accurate, exact Riemann method with added capabilities for second-order spatial accuracy, second-order accurate implicit time stepping and viscous/turbulence effects. The software uses a compact, cell-centered, finite-volume approach for arbitrary grid cells that are bounded and connected through sets of polygonal faces. As such, the method is not coupled or tied directly to a specific grid generation technique, and any preprocessor choice may be used. Five basic tasks comprise the process to solve the fluid equations of motion: (1) construction of initial conditions for the Riemann problem at any given face, (2) solution of this problem, (3) construction of viscous fluxes, (4) advancement of the entire equation set in time, and (5) updating of the computational boundaries. This process is an iterative one that proceeds for the entire computational domain, usually consisting of millions of grid cells, until a final solution is obtained. The fluid dynamic properties are then integrated over the configuration to determine aerodynamic characteristics.